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Reaction of Coffee Hybrids for major Coffee diseases in south western Ethiopia.

Demelash Teferi[1], Kifle Belachew[1], Gabissa Gidissa,[1] Legesse Hagos[1] Wakuma Getachew [2]

[1]EIAR, Jimma Research Center, P.O.Box 192 Jimma, Ethiopia.

[2]EIAR, Tepi Research. Center

Abstract
In Ethiopia, pure-line selection and intra-specific hybridization are commonly used of coffee breeding principles. Since the start of hybridization program several sets of hybridization experiments to study combining ability and inheritance of characters and develop improved hybrid varieties were conducted. Based on the on-station and verification evaluation data; three hybrids; namely, Aba-buna Melko CH2 and Gawe were released in 1998 and in 2002. Mean yield of the hybrids ranged from 24-26 q/ha on research station and about 13-20 q/ha in farmers field. To exploit the yield advantage of coffee hybrids a total of 15 hybrid coffees and two standard checks (Ababuna and Dessu at Melko and Ababuna and Geisha at Tepi) were planted at Jimma and Tepi in 2008 in RCB designs using three replications. Major coffee disease data were collected for three years for Coffee berry disease (CBD)and two years for coffee leaf rust (CLR). There was significant difference among hybrid coffee varieties in CBD at Melko CLR infection at Melko and Tepi. Released coffee varieties used for the crosses were found susceptible to the most economically important disease known as coffee wilt disease under laboratory condition. Based on overall assessment Coffee hybrids H5 (TepiHC5) , H7 (Melko-Ibsitu) and H8 (EIAR 50/CH) with CBD severity value which ranges 1.3-7 and CLR severity value of 1.1-8.4 % was approved to be used by the user for low and mid altitude coffee growing of areas of south west Ethiopia..
Keywords: *Southwest Ethiopia coffee hybrid, Coffee berry disease,Coffee leaf rust, Coffee wilt disease.*
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1. Introduction

The significance of coffee in the Ethiopian economy is enormous in that it accounts for 29 % of the total export earnings of the nation, 4.7 million small-holders directly involved in producing coffee and about 25 million people directly or indirectly depends on coffee sector for their livelihoods (CSA, 2015) . Globally, coffee is the second most traded commodity in volume of trade after petroleum. Over 56 developing countries that produce and export coffee generate a total of about US$19.1 billion annually (ICO, 2014).

Coffee grows at various altitudes, ranging from 550 to 2750 meters above sea level (m a.s.l) . However, Arabica is best thrives and produced between altitudes of 1300 and 1800 m a.s.l, with annual rainfall amount ranging from 1500 to 2500 mm with an ideal minimum and maximum air temperatures of 15 and 25 0C, respectively (Bayetta , 2001).

it has been observed that it is rarely possible to improve yield above 18 or 20qt/ha through direct selection indicating the need to look for heterotic hybrids to maximize yield as high as 25 or 30q/ha. in effect three hybrids; namely, Aba-buna Melko CH2 and Gawe were released in 1998 and in 2002. Mean yield of the hybrids ranged from 24-26 q/ha on research station and about 13-20 q/ha in farmers field (Behailu et al., 2008) . The released coffee hybrids are doing well for commercial production for South Western Ethiopia of mid and low altitude areas, as they are not resistant to CBD. To develop additional coffee hybrids for south western Ethiopia 15 hybrid coffees and two standard checks (Ababuna and Dessu at Melko and Ababuna and Geisha at Tepi) were planted at Jimma and Tepi in 2008 in RCB designs using three replications. Therefore this paper presents reaction of fifteen coffee hybrids and three standard checks to major coffee diseases.

2. Material and methods

2.1 Description of the study area

The experiment was carried out at Jima and Tepi Research Center respectively from 2008-2017 cropping season at Jima and Sheka Zone . Jimma Agricultural Research Center is sited in Oromiya region, Jimma zone, located around $7^0$46'N latitude and 36^0 E longitude With an altitude of 1753 m.a.s.l. The annual average minimum and maximum air temperatures are 11.3^{0}C and 26^0 C, respectively. It represents the medium agro-ecological coffee growing zones, which receives annual rainfall of 1550 mm.. The Tepi Agricultural Resaerch Center is located 07,º10', 54.5" N Latitude and 35º , 25 ' , 04.3" E longitude in Sheka Zone, Yeki woreda. It is characterized a low-altitude area with an altitude of 1200 m a.s.l.

2.2 Experimental materials

The experimental materials consisted of Fifteen hybrids with three standard checks, Ababuna, Dessu and Gesha were planted in verification plots in 2008 using randomized complete block design (RCBD) with three replications, planted 16 trees per plot and all cultural practices such as slashing, application of fertilizer at recommended rate; weeding, herbicide application, pruning, etc and other activities were done properly and timely as per the recommendation .The coffee accessions were timely assessed for their reaction to diseases like CBD, CWD and leaf rust under field and laboratory conditions.

Table1. List of parental coffee genotypes and their place of origin

Crosses	Zone
74165 X Dr1	Iluababor, Sidama
74140 X Dr1	Iluababor, Sidama
75227 X Dr1	Jima, Sidama
F-59 X H15	Kafa, Sidama
F-59 X Dr1	Kafa Sidama
741 X 7455	Jima, Kafa,
F-59 X H13	Kafa, Sidama
7455 X 7530	Kafa,
221A71 X 1377	Benchmaji, Gedeo
74110 X 1377	Iluababor, Gedeo
74158 X 1377	Iluababor, Gedeo
74158 X 1577	Iluababor, Gedeo
74158 X 221A71	Iluababor, Bench Maji
74110 X 20071	Iluababor, Bench Maji
20071 X 1577	Bench Maji, Gedeo
741x F-59	Jima, Kafa
Geisha	International coll
F-59	Kafa

2.3 Testing for CBD resistance

Attached berry test (ABT) technique was used to verify the CBD resistance levels by artificially inoculating expanding coffee berries on three primary branches selected from the middle canopy layer of a sample coffee tree (3 – 5 trees/plot) in the fields. These branches were inoculated after 5:00 PM by spraying 2 x 10^6 conidia/ml using manually pressurized hand sprayer. Each inoculated branch was immediately covered with plastic sleeves misted with water over night to favour infection and removed the next day before 8:00 AM. Three weeks later, the number of healthy and CBD infected berries per branch were recorded to calculate percentage berry infection. The percentages of CBD infection per tree were estimated visually to estimate the level of CBD under field conditions the percentage of diseased berries on individual trees were assessed.

2.4 Testing for resistance to Coffee Wilt Disease

Coffee accessions were tested for their reaction to coffee wilt. The seedlings (20/box) were inoculated at fully opened cotyledon stage (8-10 weeks old) with viable conidial suspension of the CWD pathogen (*G. xylarioid*es) isolate by stem nicking technique (Pieters and Van der Graaff 1980; Adugna G , 2004). The number of wilting seedlings per box (based on external symptoms) and days to the first symptom appearance were recorded

fortnightly for 6 months, and finally percentages of dead seedlings and incubation periods (day) were used for analyses

2.5 Testing for resistance to Coffee Leaf Rust

Each accession were considered for field CLR disease assessment using visual method. The percentages of diseased leaves of individual trees were assessed.

The analysis of variance (ANOVA), were performed with SAS version 9.2 (SAS institute, 2008).

3. Result and Discussion

Coffee hybrids were evaluated for the most economically important diseases on coffee , coffee berry disease (CBD) and coffee leaf rust. Following this there existed highly significant ($P<0.001$) difference among coffee accessions both in percent CBD and CLR. Disease severity varied between 0.3-14.9 and 5.0-20.1 for CBD and CLR respectively at Melko. Disease severity for coffee leaf rust varied between 0.3 -14.1 at Tepi. The level CBD was found high in 2015 as compared to the previous years (Table 1). coffee hybrids HC-4, HC-13, HC-3and HC-7 expressed CBD severity value of 10.24, 10.5, 15.17 and 20.82 % respectively. The released coffee variety Dessu shows susceptible reaction (44.56%).In attached berry test HC-7, HC-12, HC-9, HC-4 and Ababuna shows CBD severity value 13.71, 8.26, 7.62, 7.23 and 6.51 % respectively. The remaining coffee hybrids express less than five percent CBD infection in attached berry test under field condition. Higher CBD infection was associated with prevalence of low temperature of about 21.5 ^{0}C accompanied by high rainfall (> 700 mm) extended over a longer period (> 74 days) favoured CBD development and increased the disease intensity (Girma, 1995). In the same manner the level of CLR is relatively higher for the year 2015. Coffee leaf rust incidence was high when trees had high berries because more nutrients were translocated to fruits rendering leaves more susceptible for rust attack. While the fruits are filling out, the bean endosperm act as powerful sink that can attract over 70% of the total photosynthates produced by the tree at the expense of growing regions of the tree (Chala J, 2009).

There was significant difference among hybrids for CLR infection at Tepi. Most of coffee hybrids exhibited less than 10 % CLR severity at except HC-15, HC-14, HC-12, HC-9 and HC-13 with infection percent 14.1,12.9, 12.4, 11.8 and 11% respectively.

Released coffee varieties used for as a parental line were evaluated for their resistance to coffee wilt disease, the result of seedling inoculation clearly demonstrated that released coffee varieties used for the crosses were found susceptible to the most economically important disease known as coffee wilt disease (Demelash and kifle, 2015) (Table 3).

Table 2:- Reaction of mid and low land Hybrid coffee varieties to CBD , CLR and B/dieback at Melko and Tepi

	Jimma									Tepi			
Coffee hybrids	**CBD VA %**			**3years mean**	**CBD ABT%**	**CLR**			**3years mean**	**CLR**			**Branch dieback**
	2013	**2014**	**2015**			**2013**	**2014**	**2015**		**2013**	**2015**	**2yrs mean**	2014
HC-1	1.97	0	7.83	3.2	3.12	2.34	3.33	9.24	5	0.62	1.44	1	2.67
HC-2	2.19	0	2.13	1.4	2.29	4	7.46	10.24	7.2	1.48	1.22	1.4	3.17
HC-3	1.48	0	15.17	5.6	1.33	6.5	4.5	11.08	7.4	0.43	3	1.7	2.59
HC-4	0.49	0	10.24	3.6	7.23	4.51	6.92	11.8	7.7	3.95	7.44	5.7	2.29
HC-5	2.97	1.93	3.93	2.9	5.09	7.3	4.13	11.76	7.7	1.48	2.78	2.1	2.04
HC-6	2.59	0	1.33	1.3	1.75	3.21	1.17	9.89	4.8	1.89	0.22	1.1	2
HC-7	0.29	0	20.82	7	13.71	4.71	5.54	15.02	8.4	0.88	6.67	3.8	1.75
HC-8	0.15	0	4	1.4	2.73	5.4	1.04	9.7	5.4	2.92	0	1.5	1.92
HC-9	0.71	0.93	2.83	1.5	7.62	21.67	13.54	25.13	20.1	5.83	17.78	11.8	1.88
HC-10	0.17	0	0.85	0.3	3.11	10.8	7.42	15.33	11.2	5.43	13.33	9.4	2.55
HC-11	0.22	0	3.34	1.2	3.58	11.88	9.58	13.46	11.6	5.22	13.56	9.4	2.5
HC-12	0.97	0	5.3	2.1	8.26	9.63	7.71	19.67	12.3	8.13	16.67	12.4	2.55
HC-13	1.74	0	10.5	4.1	6.63	12.13	5.5	15.19	10.9	10.23	11.78	11	2.38
HC-14	0.29	0	6.63	2.3	1.06	14.08	6.58	17.94	12.9	10.84	15	12.9	2.55
HC-15	1.23	1.73	4.69	2.6	5.03	17.46	11.83	17.85	15.7	12.71	15.56	14.1	2.46
Aba buna	0.27	0.14	3.2	1.2	6.51	5.29	7.92	12.76	8.7	1.26	7.22	4.2	2.17

Table 3. Reaction of parental lines (released coffee varieties) and previous released coffee hybrids against coffee wilt disease

Variety/ Accession	Severity (%)		Incubation period (days)
	Actual value	Transformed value	
741	78.46	66.94	75
74110	86.17	71.94	89
74140	90	78.93	87
74158	90	71.95	80.33
74165	88.33	70.11	81.67
75227	92.57	77	78.67
Ababuna*	92.6	80.63	76.67
Melko-CH2*	89.07	75.09	83.67
Gawe*	90.28	75.07	87
Gesha	97.23	84.42	60.67
Dessu	100	90	70.67
3/70**	15.13	22.79	141.67
Mean	84.2	72.1	84.3
SD	22.4	16.7	19.7

4. Conclusion and Recommendations

Based on the verification evaluation data; three hybrids; namely, HC-5 (Tepi hybrid 5) , HC- 6 (Melko Ibsitu) and HC-8 (EIAR-50) which showed very low and acceptable disease severity of coffee berry disease and coffee leaf rust compared with the checks, were recommended to be used in mid and low land areas where coffee berry disease is not a problem. All plants require an adequate supply of nutrients to grow and yield well and coffee is no exception. If the supply of nutrients is insufficient, especially for high yielder hybrid variety coffee trees may be affected by coffee leaf rust and die back. *G. xylarioides* penetrates through wounds, so any agent causing wounds will aid the spread of the fungus. Thus avoid wounding during weeding and pruning is recommended. It is also advisable to sterilize Secateurs and hand saw that are used in pruning an process. Once the disease is identified, the infected coffee bushes should be up rooted and burning them on the spot contributes in limiting the spread of *G. xylarioides* inoculums.

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